

IN THE CLAIMS

1. (Currently Amended) A plasma processing apparatus for applying a process to a substrate to be processed, the plasma processing apparatus comprising:

a chamber of which interior can be depressurized,

a gas supply system constructed and arranged to supply a gas to the chamber and an exhaust system configured and arranged to exhaust the gas supplied to the chamber and to depressurize the chamber;

a part of a wall constituting the chamber being a flat plate dielectric material plate formed of a material which passes a microwave therethrough substantially without a loss;

a flat plate dielectric material shower plate, which is formed of a material which passes a microwave therethrough substantially without a loss, being provided between the dielectric material plate and plasma excited in the chamber;

a plurality of gas discharge holes being formed in the dielectric material shower plate so that at least a part of the gas supplied by the gas supply system is discharged through the plurality of gas discharge holes through a gap between the dielectric material plate and the dielectric material shower plate;

a flat plate slot antenna being provided on an outer side of the chamber with the dielectric material plate interposed therebetween so as to supply a microwave for exciting plasma through the dielectric material plate;

an electrode being provided on an inner side of the chamber so as to hold the substrate to be processed;

a lattice-like shower head provided between the dielectric material shower plate and the substrate to be processed so as to discharge a gas, which has a composition different from that of the gas discharged from the dielectric material shower plate, to a side of the substrate to be processed; and

at least a part of the gas discharged from the dielectric material shower plate flows to the side of the substrate to be processed by being passed through an opening part of the lattice-like shower head,

wherein said lattice-like shower head is formed of a metal pipe comprising a plurality of gas discharge holes configured and arranged such that a normal to each of said holes is

oblique to the surface of the substrate, and each of said holes is formed on a curved surface of said metal pipe, and

wherein none of the plurality of gas discharge holes in said lattice-like shower head has a normal perpendicular to the surface of the substrate.

2. (Previously Presented) The plasma processing apparatus claimed in claim 1, wherein said plurality of gas discharged holes are provided to the metal pipe on a side facing the substrate to be processed, and the metal pipe is grounded.

3. (Previously Presented) The plasma processing apparatus as claimed in claim 2, wherein said metal pipe is formed of a stainless steel containing aluminum, and a surface thereof is covered by a passivation film mainly formed of aluminum oxide.

4. (Previously Presented) The plasma processing apparatus as claimed in claim 1, wherein said dielectric material shower plate and said lattice-like shower head are arranged substantially parallel to each other, and a distance therebetween is substantially equal to a multiple of a quarter of a wavelength of said microwave in a vacuum.

5. (Previously Presented) The plasma processing apparatus as claimed in one of claims 1 to 4, wherein said dielectric material plate and said dielectric material shower plate are arranged substantially parallel to each other, and a distance between a surface of said dielectric material plate facing said slot antenna and a surface of the dielectric material shower plate facing said substrate to be processed is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a corresponding part.

6. (Previously Presented) The plasma processing apparatus as claimed in claim 5, wherein said slot antenna and said dielectric material plate are arranged substantially parallel to each other, and a distance therebetween is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a corresponding part.

7. (Previously Presented) The plasma processing apparatus as claimed in one of claims 1 to 4, wherein a thickness of said dielectric material shower plate is an integral multiple of a half of a wavelength of said microwave in a corresponding part.

8. (Previously Presented) The plasma processing apparatus as claimed in claim 7, wherein said slot antenna and said dielectric material plate are arranged substantially parallel to each other, and a distance therebetween is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a corresponding part.

9. (Withdrawn) A plasma processing apparatus for applying a process to a substrate (812) to be processed, the plasma processing apparatus comprising a chamber (801) of which interior can be depressurized, a gas supply system for supplying a gas to the chamber and an exhaust system for exhausting the gas supplied to the chamber for depressurizing the chamber; a part of a wall constituting the chamber (801) being a flat plate dielectric material plate (802) formed of a material which passes a microwave therethrough substantially without a loss; a part of a wall of the chamber other than the dielectric material plate is a grounded metal wall; a flat plate dielectric material shower plate (803), which is formed of a material which passes a microwave therethrough substantially without a loss, being provided between plasma excited in the chamber and each of the dielectric material plate (802) and the metal wall; a plurality of gas discharge holes (807) being formed in the dielectric material shower plate so that at least a part of the gas supplied by the gas supply system is discharged through the plurality of gas discharge holes (807) through a gap (804) between the metal wall and the dielectric material shower plate (803); a single mode waveguide (808) having a wall a part of which is the dielectric material plate (802) being provided on an outer side of the chamber (801) with the dielectric material plate (802) interposed therebetween; an electrode (813) being provided on an inner side of the chamber so as to hold the substrate (812) to be processed,

characterized in that the lattice-like shower plate (809) is provided between the dielectric material shower plate (803) and the substrate (812) to be processed so as to discharge a gas, which has a composition different from that of the gas discharged from the dielectric material shower plate, to a side of the substrate to be processed; and

at least a part of the gas discharged from the dielectric shower plate (803) flows to the side of the substrate to be processed by being passed through an opening part of the lattice-like shower plate (809).

10. (Withdrawn) The plasma processing apparatus as claimed in claim 9, characterized in that said lattice-like shower plate (809) is formed of a metal pipe; a plurality of gas discharge holes (811) are provided to the metal pipe on a side facing the substrate to be processed, and the metal pipe is grounded.

11. (Withdrawn) The plasma processing apparatus as claimed in claim 10, characterized in that said metal pipe is formed of a stainless steel containing aluminum, and a surface thereof is covered by a passivation film mainly formed of aluminum oxide.

12. (Withdrawn) The plasma processing apparatus as claimed in one of claims 9 to 11, characterized in that said dielectric material shower plate (803) and said lattice-like shower plate (809) are arranged substantially parallel to each other, and a distance therebetween is substantially equal to a multiple of a quarter of a wavelength of said microwave in a vacuum.

13. (Previously Presented) A plasma processing apparatus for applying a process to a substrate to be processed, the plasma processing apparatus comprising:

a chamber of which interior can be depressurized;

a gas supply system constructed and arranged to supply a gas to the chamber and an exhaust system configured and arranged to exhaust the gas supplied to the chamber and to depressurize the chamber;

a part of a wall constituting the chamber being a flat plate dielectric material plate formed of a material which passes a microwave therethrough substantially without a loss;

a flat plate dielectric material shower plate, which is formed of a material which passes a microwave therethrough substantially without a loss, being provided between the dielectric material plate and plasma excited in the chamber;

a plurality of gas discharge holes being formed in the dielectric material shower plate so that at least a part of the gas supplied by the gas supply system is discharged through the

plurality of gas discharge holes through a gap between the dielectric material plate and the dielectric material shower plate;

a flat plate slot antenna being provided on an outer side of the chamber with the dielectric material plate interposed therebetween so as to supply a microwave for exciting plasma through the dielectric material plate;

an electrode being provided on an inner side of the chamber so as to hold the substrate to be processed,

wherein the slot antenna, the dielectric material plate and the dielectric material shower plate are arranged substantially parallel to each, and a distance between a surface of the dielectric material plate facing said slot antenna and a surface of said dielectric material shower plate facing said substrate to be processed is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a corresponding part.

14. (Previously Presented) The plasma processing apparatus as claimed in claim 13,

wherein a thickness of said dielectric material shower plate is an integral multiple of a half of a wavelength of said microwave in a corresponding part.

15. (Previously Presented) The plasma processing apparatus as claimed in claim 13 or 14,

wherein a distance between said slot antenna and said dielectric material plate is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a corresponding part.

16. (Previously Presented) A plasma processing apparatus for applying a process to a substrate to be processed, the plasma processing apparatus comprising:

a chamber of which interior can be depressurized,

a gas supply system constructed and arranged to supply a gas to the chamber and an exhaust system constructed and arranged to exhaust the gas supplied to the chamber and to depressurize the chamber;

a part of a wall constituting the chamber being a flat plate dielectric material plate formed of a material which passes a microwave therethrough substantially without a loss;

a flat plate dielectric material shower plate, which is formed of a material which passes a microwave therethrough substantially without a loss, being provided between the dielectric material plate and plasma excited in the chamber;

a plurality of gas discharge holes being formed in the dielectric material shower plate so that at least a part of the gas supplied by the gas supply system is discharged through the plurality of gas discharge holes through a gap between the dielectric material plate and the dielectric material shower plate;

a flat plate slot antenna being provided on an outer side of the chamber with the dielectric material plate interposed therebetween so as to supply a microwave for exciting plasma through the dielectric material plate;

an electrode being provided on an inner side of the chamber so as to hold the substrate to be processed;

a lattice-like shower head provided between the dielectric material shower plate and the substrate to be processed so as to discharge a gas, which has a composition different from that of the gas discharged from the dielectric material shower plate, to a side of the substrate to be processed; and

at least a part of the gas discharged from the dielectric material shower plate flows to the side of the substrate to be processed by being passed through an opening part of the lattice-like shower head,

wherein said dielectric material shower plate and said lattice-like shower plate head are arranged substantially parallel to each other, and a distance therebetween is substantially equal to a multiple of a quarter of a wavelength of said microwave in a vacuum.

17. (Previously Presented) A plasma processing apparatus for applying a process to a substrate to be processed, the plasma processing apparatus comprising:

a chamber of which interior can be depressurized,

a gas supply system constructed and arranged to supply a gas to the chamber and an exhaust system constructed and arranged to exhaust the gas supplied to the chamber and to depressurize the chamber;

a part of a wall constituting the chamber being a flat plate dielectric material plate formed of a material which passes a microwave therethrough substantially without a loss;

a flat plate dielectric material shower plate, which is formed of a material which passes a microwave therethrough substantially without a loss, being provided between the dielectric material plate and plasma excited in the chamber;

a plurality of gas discharge holes being formed in the dielectric material shower plate so that at least a part of the gas supplied by the gas supply system is discharged through the plurality of gas discharge holes through a gap between the dielectric material plate and the dielectric material shower plate;

a flat plate slot antenna being provided on an outer side of the chamber with the dielectric material plate interposed therebetween so as to supply a microwave for exciting plasma through the dielectric material plate;

an electrode being provided on an inner side of the chamber so as to hold the substrate to be processed;

a lattice-like shower head provided between the dielectric material shower plate and the substrate to be processed so as to discharge a gas, which has a composition different from that of the gas discharged from the dielectric material shower plate, to a side of the substrate to be processed; and

at least a part of the gas discharged from the dielectric material shower plate flows to the side of the substrate to be processed by being passed through an opening part of the lattice-like shower head,

wherein said dielectric material plate and said dielectric material shower plate are arranged substantially parallel to each other, and a distance between a surface of said dielectric material plate facing said slot antenna and a surface of the dielectric material shower plate facing said substrate to be processed is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a corresponding part.

18. (Previously Presented) The plasma processing apparatus as claimed in claim 17,

wherein said slot antenna and said dielectric material plate are arranged substantially parallel to each other, and a distance therebetween is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a corresponding part.



19. (Previously Presented) The plasma processing apparatus as claimed in claim 16,

wherein a thickness of said dielectric material shower plate is an integral multiple of a half of a wavelength of said microwave in a corresponding part.

20. (Previously Presented) The plasma processing apparatus as claimed in claim 19,

wherein said slot antenna and said dielectric material plate are arranged substantially parallel to each other, and a distance therebetween is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a corresponding part.

21. (Canceled)

22. (Previously Presented) The plasma processing apparatus as claimed in claim 1, wherein a normal to each hole in a first portion of said plurality of gas discharge holes is inclined inwardly towards a center of said substrate and a normal to each hole in a second portion of said plurality of gas discharge holes is inclined outwardly away from the center of said substrate.

23. (Previously Presented) The plasma processing apparatus as claimed in claim 1, wherein the gas exiting through said plurality of discharge holes is evenly spread over substantially the entire surface of the substrate.